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COSTS, RISKS AND TIMING OF DECISIONS FOR PEACEKEEPING OPERATIONS

by

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ABSTRACT

A method for options analysis is presented. Using a number of quantitative tools, decision makers can identify courses of action that reduce unnecessary spending on preparations while managing deployment risks. The method is illustrated with reference to example cases of peacekeeping operations.

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COSTS, RISKS AND TIMING

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INTRODUCTION

1. This paper describes a planning approach that has been used recently within the Department of National Defence in Canada to support decision-making with regard to timing, cost and deployment risk for peacekeeping operations. The method is intended to maximise the efficiency of resource utilisation. Specifically, it is designed to identify feasible courses of action that meet operational requirements within contingent response times at minimal cost.

2. The approach was developed by the Joint Staff Operational Research Team in conjunction with staff of J3 Plans and Operations at National Defence Headquarters. It is based on a number of previous analytical studies by the authors [References 1,2 and 3].

3. Discussion of the analytical approach and its potential utility in the remainder of the report will be structured as follows:

a. Background;

(1) business planning

(2) performance measurement

b. Trade-off Analysis with Example Cases;

(1) time/cost/risk analysis

(2)- Bosnia

(3) Zaire

c. General Method;

(1) critical path analysis with resource constraints

(2) event trees

(3) expected values

d. Conclusions.

BACKGROUND

4. Canada has traditionally been a fervent supporter of peacekeeping operations. However, managers of defence resources are motivated to reduce spending, subject to the mandate of government policy and direction. In spite of reductions in budgets, the Canadian Forces (CF) continue to be committed to peacekeeping and humanitarian assistance. The responsiveness, effectiveness and versatility of CF employment must be balanced against monetary constraints. Hence, analytical techniques are needed to assess the various trade-offs that are imposed by reducing resources.

5. In the spirit of continuous improvement, principles of "business planning" and "performance measurement" are being applied throughout the Department of National Defence and all branches of the Canadian Forces in order to garner optimal return on investment in defence resources. There are a number of facets to the problem of business planning in the military context. Among the most important are:

a. readiness,

b. resource allocation and resource levelling,

c. risk management, and

d. cost-effectiveness.

Let us consider each of them briefly.

6. The term *readiness* refers to the ability of armed forces to generate sufficient and appropriate military capability within acceptable response times. Being "ready" implies that personnel, equipment, infrastructure, logistic support and Command and Control (C^2) arrangements are kept at adequate levels, in terms of quantity and proficiency, to undertake operations after a planned phase of final preparations. This implies that planners must anticipate the nature and standards of capabilities that might be required. As well, they must estimate the time intervals that might limit the response time ultimately available for final preparations. Given the uncertainty of regional military balances in today's world order, the problem of evaluating time and capability requirements is a considerable challenge.

7. Having defined capabilities and readiness requirements, planners must decide upon *resource allocation*. A rigorous assessment of "what" and "how much" should be provided for the defined capabilities so that prescribed task standards and readiness levels can be achieved with reasonable levels of assurance. Furthermore, managers must ensure that resources and taskings are assigned proportionally and uniformly among comparable military units. This principle is referred to as *resource levelling* and is intended to foster uniform standards of quality and productivity in the achievement of military capabilities.

8. As previously noted, planners must ensure that standards and readiness levels can be achieved with "*reasonable levels of assurance*". Resource limitations imposed by business planning give rise to a certain amount of *risk* that an unexpected period of high demand on capabilities will result in an inability to generate and sustain all of the required

capabilities. Planners should *manage* risks so that the occurrence of insufficient response becomes a remote possibility. *Risk management* refers to the identification and quantification of risks and the creation of contingency plans to avert unacceptable outcomes.

9. It is important to draw a distinction between *performance* in the business planning sense and *performance* in the military capability sense. The former refers to the relative economic efficiency of maintaining, generating and sustaining the assigned military capabilities of an armed force, while the latter refers to the relative proficiency of an armed force to achieve, (in terms of skill, power and timeliness), assigned operational objectives. The term performance is widely used in both senses with reference to armed forces.

10. The term *cost-effectiveness* relates the capability and proficiency that is required, to the monetary outlay needed to obtain it. The purpose of this paper is to describe a general approach for identifying cost-effective options for peacekeeping operations.

11. The example cases, presented below, represent planning considerations for two distinct operational objectives. The peacekeeping mission in Bosnia (Op Palladium) is primarily a peace-support operation, while the aborted mission to Zaire (Op Assurance) would have been primarily for humanitarian assistance. Both examples will examine sufficiency and timeliness of response against cost considerations.

TRADE-OFF ANALYSIS WITH EXAMPLE CASES

12. The method makes use of a number of standard tools of quantitative analysis. They are:

a. activity-oriented models;

b. event trees or decision trees;

c. timelines; and

d. expected values.

13. In the defence context, it is useful to define an "activity" as "an element of work that turns resources into military capabilities which satisfy prescribed task standards". Our goal is to model capability surge processes in terms of *activities* because the activity-oriented approach allows two powerful analytical techniques to be applied to the problems of trade-off analysis. They are:

a critical path analysis with resource constraints; and,

b. activity-based costing.

14. It is important to draw attention to *resource constraints* when referring to the application of critical path analysis. The well-known network labelling algorithm for finding the shortest completion time of a set of activities with precedence relationships [*c.f.* Reference 4] is valid only if there are sufficient resources available to perform concurrent tasks. If this resource condition is not satisfied, then the shortest completion time of the activities will be longer. In such cases, a more sophisticated approach is required to optimise the completion time. Algorithms of the "branch-and-bound" type can be devised for these cases. Sophisticated commercial codes for project scheduling include such algorithms.

15. A generic activity-oriented view of capability "surge" preparations is shown in Figure 1.

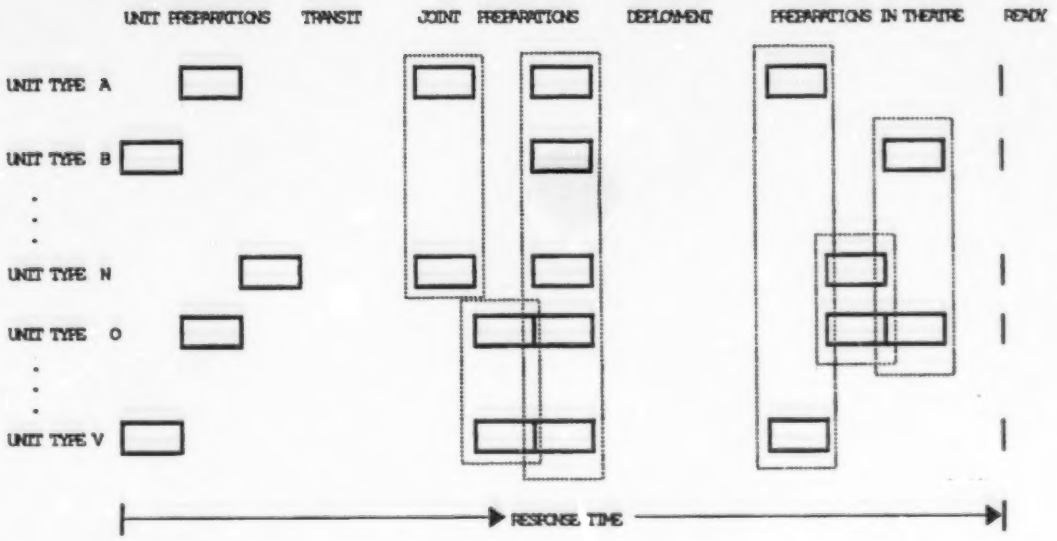

Figure 1: Activity-oriented view of surge preparations

16. Figure 1 depicts that a number of military units of various types may undergo unit level preparations prior to deployment, they may be transported for joint preparations prior to deployment, they may undergo joint preparations prior to deployment and after deployment, they may undergo joint preparations in theatre. Some or all of these activities may or may not take place for some or all of the unit types under consideration, depending on the specific requirements of the operation. Preparations might consist of such activities as training, equipment configuration, maintenance and stock-pile generation, for example.

17. Against the preparations depicted in Figure 1, the question of the types of units that should be prepared, the nature and locations of the preparations and the specific units of each type that should be prepared for deployment, must be decided. It is often the case, however, that strategic and operational requirements change between the initial mission planning and the ultimate deployment. In order to manage the inherent uncertainty and the consequent risk of not being adequately ready to meet operational objectives, an assessment of the likelihood of the need for various capability requirements can be made using a decision tree.

18. Consider for example, the main uncertainties that existed during planning for Op Palladium (SFOR) in the autumn of 1996, for the follow-on Canadian force in Bosnia after Op Alliance (IFOR). In order not to clutter the discussion with unnecessary details, suffice it to say that planners faced three primary options:

a. full battalion group;

b. reduced battalion group; and

c. no follow-on force.

19. The decision environment rested upon a number of key questions:

a. would there be a UN resolution supporting a follow-on force (?);

b. would there be participation by the United States (?);

c. would NATO establish a follow-on force (?);

d. would cabinet direct Canadian participation in a follow-on force (?); and

e. should a full Battalion Group be prepared for deployment or should a

f. reduced Battalion Group be prepared for deployment (?).

20. These questions were structured according to the decision tree illustrated in Figure 2. The decision tree maps the uncertainty into sets of potential outcomes where each potential outcome corresponds to a path from the root of the tree to a leaf node of the tree. Each of the outcomes can subsequently be associated with the appropriate deployment option for that outcome.

21. Having represented the potential outcomes using a decision tree. Military planners were asked to evaluate the relative "likelihood" of each pair of alternatives at each branch node on the tree. They were asked to assign a pair of fractional values that expressed their relative expectation for the alternatives at each branch node. Furthermore, because the alternatives cover all possible cases, the assigned fractional values at each branch point were required to sum to 1.

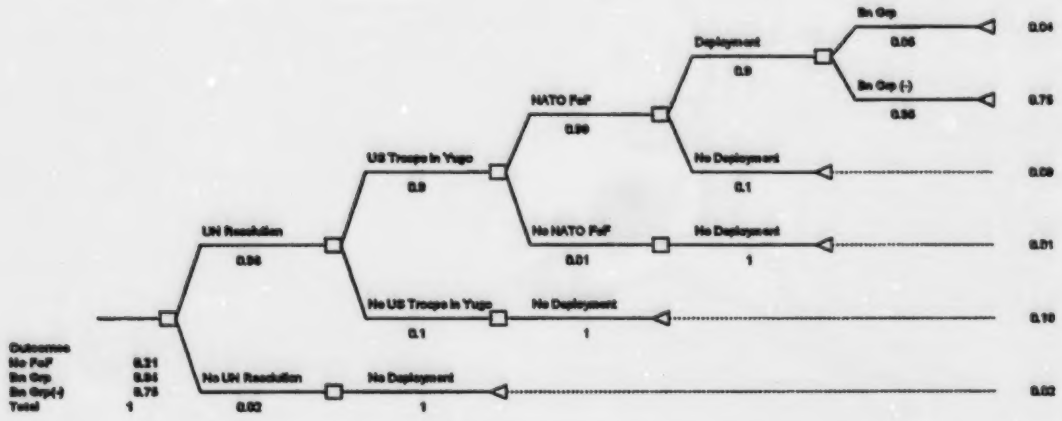

Figure 2: Decision Tree for Op Palladium Force Options

22. Because the alternatives are not random events in any sense, it is not correct to consider a likelihood as a "probability". However, the likelihoods provide a surrogate for probabilities insofar as they give a relative value for the expectation that each alternative might occur. By multiplying the likelihoods along the branches leading from the root to the leaf nodes, a relative weighting for the expectation of each overall outcome is obtained. Then, by summing the likelihoods associated with each deployment option, the relative expectation for each deployment option is obtained. For the example in Figure 2, the relative expectations are as follows:

a. for full battalion group = 0.04;

b. for reduced battalion group = 0.75; and

c. for no follow-on force = 0.21.

23. The highest relative expectation was that a reduced battalion group would be deployed. Note, however, that there was a significant relative expectation that there would be no follow-on force, while the full battalion group option had a very small relative expectation. As of September 1996, therefore, it seemed reasonable to continue preparations for the reduced battalion group option.

24. By preparing for the reduced battalion group option, no adverse effects on readiness would have been incurred if the outcome, ultimately, were no follow-on force. In such a case, the only negative consequence would have been unnecessary spending.

25. In contrast, however, by preparing for the reduced battalion group option, adverse effects on readiness might have been incurred if the outcome, ultimately, were to deploy the full battalion group. In this case, a late decision to deploy the full battalion group might have resulted in insufficient time for final surge preparations. Subsequently, the Canadian contingent might have been late declaring readiness in theatre.

26. In a highly risk-averse environment, the potential for inadequate readiness would motivate planners to prepare for the full battalion group option and to revert to the reduced battalion group option at the time of deployment if that were sufficient military response. However, the rather small relative expectation that the full battalion group option would be required, indicated that the full set of surge preparations was unwarranted. Under the circumstances, planners decided to accept the risk.

27. Having assessed the reduced battalion group option as the most likely course of action well in advance of the deployment deadline, it was possible to explore transportation options with a view to minimising the deployment cost. Figure 3 depicts a decision tree together with time/cost trade-offs for a number of transportation options:

a. tendered shipping;

b. late-tendered shipping;

c. directed contract shipping; and

d. airlift.

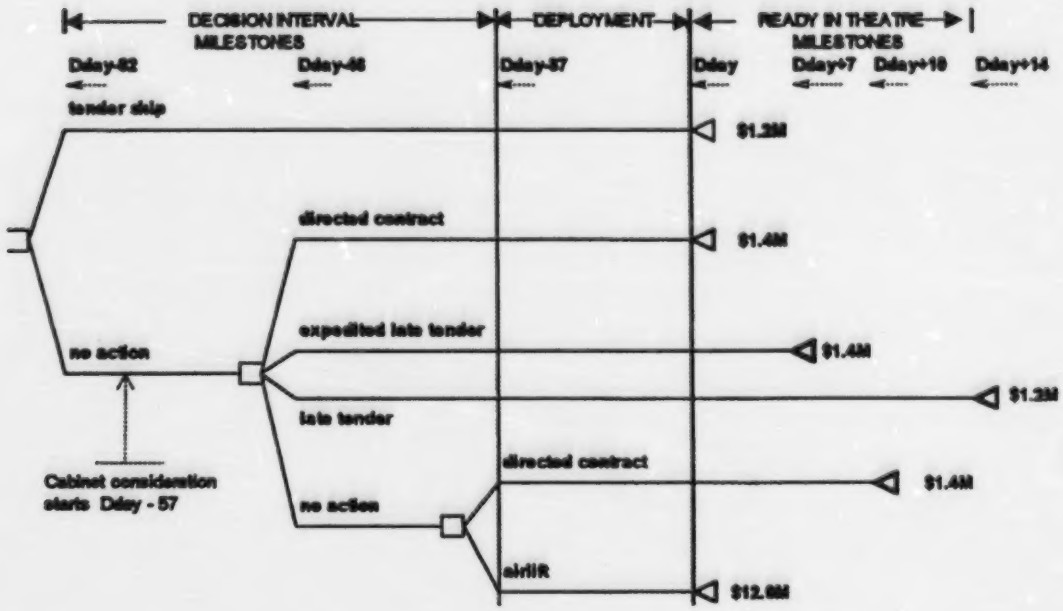

Figure 3: Decision Tree for Op Palladium Options

28. In Figure 3, "Dday" is the *due date* for declaring readiness in theatre. The various decision points are back-plotted from Dday. The time window for transportation decisions begins at Dday-62 and ends at Dday-37. The consequent outcomes in terms of readiness in theatre and cost are indicated on the timeline between Dday and Dday+14. Cabinet level direction of the transportation decision could have begun as early as Dday-57. Prior to that, however, DND could have tendered shipping in anticipation of the deployment being approved. It is clear from Figure 3 that a decision prior to Dday-46 was highly advisable in order to avoid costly airlift to meet the deadline in theatre. Ultimately a directed contract was given prior to Dday-46.

29. A similar trade-off analysis was carried out for the planned humanitarian assistance mission in Zaire, in November 1996. In this case, the main uncertainties were the following:

a. would the Canadian government support the operation (?);

b. would the operation be required (?);

c. would the operation be staged from Zaire or Rwanda (?);

d. if the operation were staged from Rwanda would there be an additional UN resolution (?);

e. would the planned response be capable of meeting the actual need (?);

f. would other nations be involved (?); and

g. would there be a permissive security environment (?)

30. In this case, the term "permissive security environment" implied that the operation could be accomplished without risk of being involved in armed hostility.

31. The uncertainties of the Op Assurance planning environment, for Zaire, were structured according to the decision tree in Figure 4. As with Op Palladium, for Bosnia, military planners were asked to evaluate the relative "likelihood" of each pair of alternatives at each branch node on the tree. Overall likelihood together with the appropriate military response option for each outcome is indicated next to the leaf nodes in Figure 4.

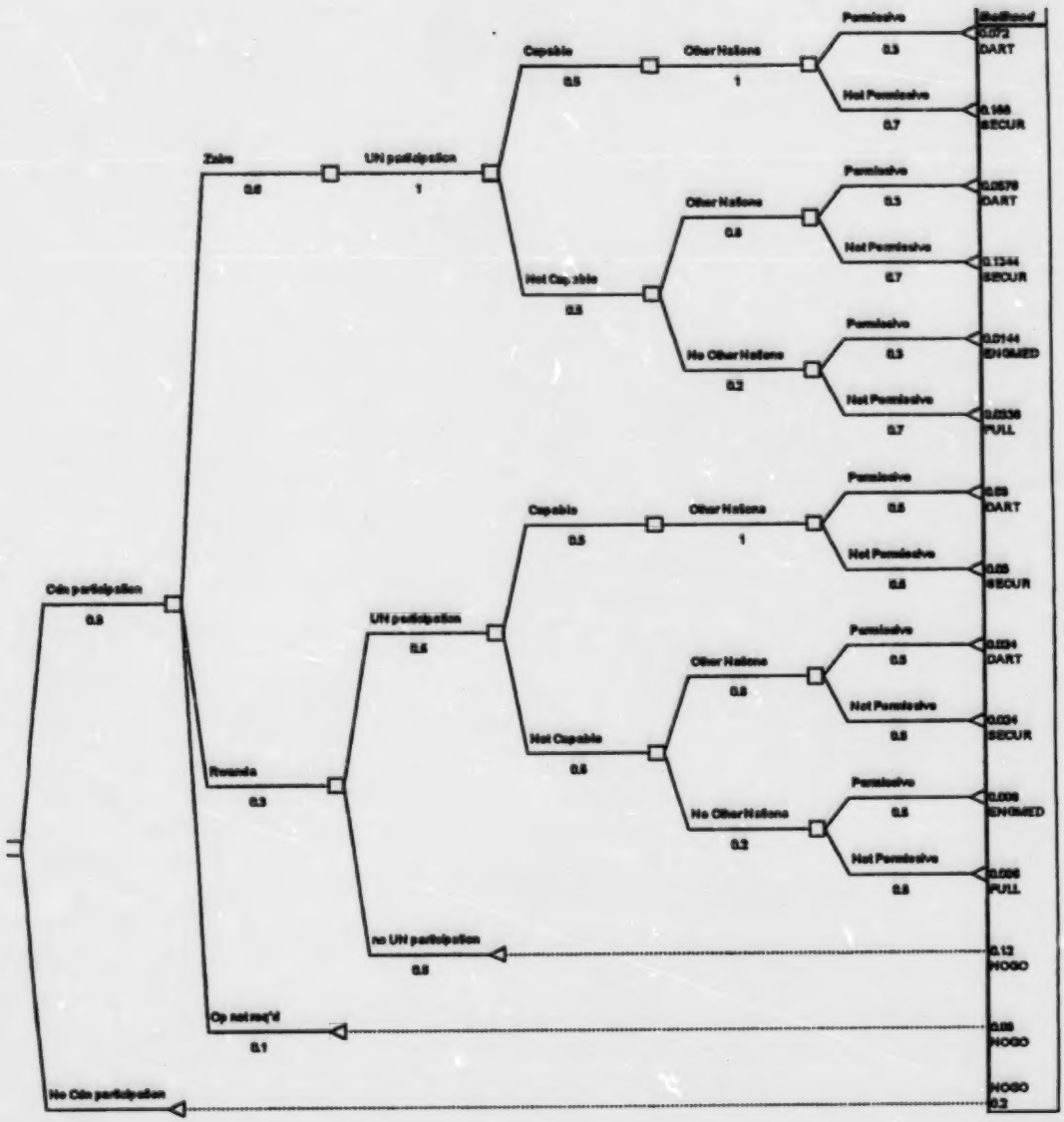

Figure 4: Decision Tree for Op Assurance Options

32. As with Op Palladium, there was the possibility that ultimately no operation would be mounted. This outcome is denoted by "NOGO", in Figure 4. The acronym "DART" signifies the Disaster Assistance Response Team. DART is the quick response humanitarian assistance specialist team that is deployed in non-hostile crises. This was the most basic response under consideration at the time. There were three additional options that were also considered:

a. to augment the DART with a security force of 80 personnel, (this option is denoted by "SECUR" in Figure 4);

b. to augment the DART with 80 additional medical and engineering personnel, (this option is denoted by "ENGMED" in Figure 4);

c. to augment the DART with both a security force and additional medical and engineering personnel, (the option denoted by "FULL" in Figure 4).

33. By summing the likelihood associated with each of the five response options, the relative expectation for each option is obtained. For the example in Figure 4, the relative expectations are as follows:

a. "NOGO" = 0.4;

b. "DART" = 0.18;

c. "SECUR" = 0.36;

d. "ENGMED" = 0.02; and,

e. "FULL" = 0.04.

Therefore, the likelihood of a "go" was 0.6, which is comparable to the likelihood of "NOGO". Among the "go" response options, "SECUR" was the most likely.

34. Because of the high relative likelihood of "NOGO", it was desirable to minimise unnecessary spending on preparations but nevertheless to make adequate preparations for a timely response if a "go" had been called for. To this end, a comparative cost and risk assessment of the various options was carried out.

35. Clearly, a careful cost estimate for each option could have been prepared, if time had permitted. However, because training, provisioning and movement of personnel drove the cost of the preparations, the cost of preparing for each option was directly proportional to the number of personnel involved. The approximation of preparation cost

using the number of personnel as a surrogate was accepted by departmental costing specialists as sufficiently accurate for initial planning.

36. Table I indicates the number of personnel involved unnecessarily by preparing for one option and then selecting any one of the others. A relative comparison of unnecessary spending was made using expected values of unnecessary personnel involvement.

TABLE I

EXPECTED VALUES OF UNNECESSARY PERSONNEL INVOLVEMENT FOR EACH OPTION

PREPARE FOR: ↓	OUTCOME IS:					UNNECESSARY SPENDING (E.V.)
	NOGO	DART	SECUR	ENGMED	FULL	
NOGO	0	0	0	0	0	0
DART	177	0	0	0	0	70.8
SECUR	257	80	0	80	0	119.12
ENGMED	257	80	80	0	0	146
FULL	337	160	80	80	0	194.32
	(unnecessary personnel involvement)					
LIKELIHOOD	0.40	0.18	0.36	0.02	0.04	

37. As to risk, timeliness of response was the most important factor and, therefore, "expected delay" was identified as the main deployment risk. The expected value of delay associated with each option is shown in Table II.

TABLE II

EXPECTED VALUES OF DELAY FOR EACH OPTION

PREPARE FOR: ↓	OUTCOME IS: NOGO	DART	SECUR	ENGMED	FULL	EXPECTED DELAY:
NOGO	0	0.3	1	1.5	1.5	0.50
DART	0	0	1	1.5	1.5	0.45
SECUR	0	0	0	1.5	1.5	0.09
ENGMED	0	0	1	0	1	0.40
FULL	0	0	0	(delay) 0	0	0.00
LIKELIHOOD	0.40	0.18	0.36	0.02	0.04	

38. A normalised comparison of cost and risk is depicted in Figure 5. The comparison reveals the pragmatic appeal of the "SECUR" option: low risk coupled with relatively low expected unnecessary spending. In a risk averse situation, preparations could have been made for "FULL" with an additional outlay for preparing 80 additional personnel.

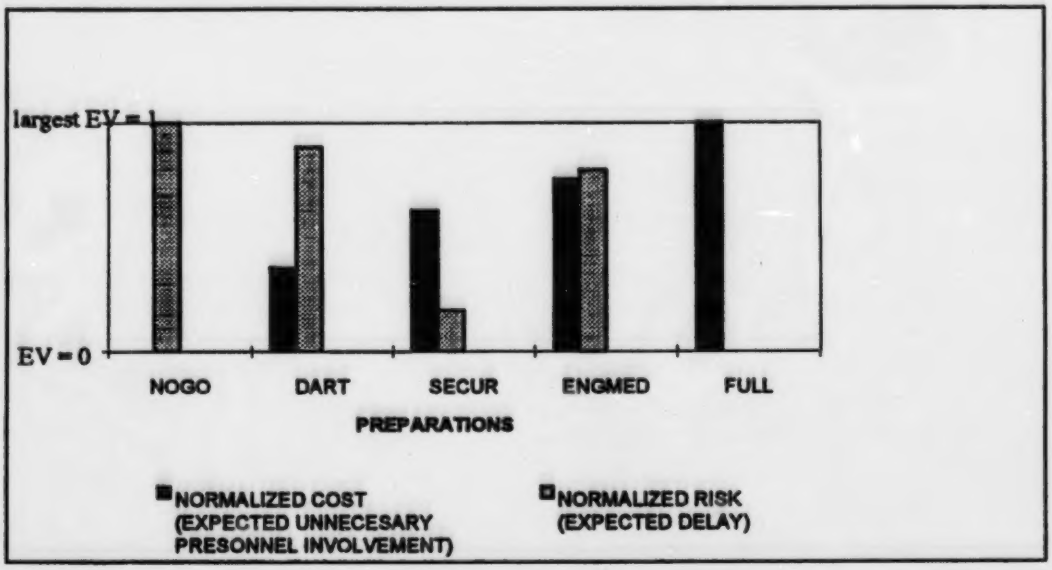

Figure 5: Comparison of Normalized Cost/Risk Expected Values

GENERAL METHOD

39. The concepts and tools used in the above examples can be used to formulate a general method for conducting options analysis:

a. identify potential options;

b. identify uncertainties which influence the choice of each option;

c. structure uncertainties into an event tree and estimate the expectation for each option;

d. for options with significantly high expectation:

(1) identify activities;

(2) determine the precedence relations among the activities;

(3) determine the resource requirements for each activity;

(4) determine the resource constraints for each resource;

(5) determine the minimum response time using critical path analysis with resource constraints;

(6) quantify timing risks;

(7) quantify other risks;

(8) make a cost estimate;

e. using expected values compare costs and risks to select courses of action for which preparations will be made.

CONCLUSIONS

40. In summary,

a. time / cost / risk analysis method is being developed and implemented;

b. specific case-studies have revealed timely and cost-effective courses of action;

c the method quantifies military judgement under uncertainty; and

d. it can support strategic, operational and even tactical level planning.

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